

PEDIATRIC OBESITY TREATMENT IN RURAL SETTINGS: ASSOCIATION BETWEEN
PSYCHOSOCIAL FUNCTIONING AND HEALTH OUTCOMES

By

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Abstract

Objective. Evaluate associations between psychological functioning, weight, and diet in rural children participating in family-based pediatric obesity interventions.

Methods. One hundred and forty-eight children participated in two trials of rural pediatric obesity interventions. Measures of internalizing, externalizing, and total behavior problems; BMIz; red food intake; and fruit and vegetable intake were taken at baseline and post-intervention. Pre- to post-intervention changes in health outcomes were assessed using paired-samples *t*-tests. Continuous and categorical associations between behavior problems and weight/diet were assessed using correlations, hierarchical linear regression models, and independent-samples *t*-tests.

Results. Across all participants, red foods and behavior problems significantly improved from pre- to post-intervention. Externalizing problems were positively associated with red foods, and clinical levels of externalizing and internalizing problems were associated with higher baseline red foods and BMIz (compared to subclinical problems).

Conclusion. Findings support associations between psychological functioning and weight/diet in rural children participating in a family-based pediatric obesity intervention. Identifying children with high baseline levels of psychological problems may help predict which children are the most or least likely to succeed in a pediatric obesity interventions as well as inform future development of interventions that are more effective in children with psychological problems.

Keywords: obesity, rural, weight management, psychological health

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Table of Contents

Acceptance Page	ii
Abstract.....	iii
Acknowledgements.....	iv
Table of Contents.....	v
Introduction	1
Current Study.....	6
Methods.....	7
Participants and Procedure.....	7
Measures.....	8
Data Analyses.....	10
Results.....	13
Descriptives.....	13
Correlational Analyses.....	14
Regression Analyses.....	14
Categorical Analyses.....	17
Discussion.....	19
Baseline Associations between Psychological Functioning and Weight/Diet.....	19
Relationship between Baseline Psychological Functioning and Changes in Weight/Diet	22
Relationship between Changes in Psychological Functioning and Changes in Weight/Diet.....	25
Limitations.....	26

Conclusions and Future Directions.....	28
References.....	29
Tables.....	41
Table I. Descriptives: Sample Characteristics.....	41
Table II. Descriptives: Psychological Functioning, Weight, and Diet.....	42
Table III. Hierarchical Regression Analyses Testing Effects of Internalizing and Externalizing Symptoms on Weight and Diet Outcomes.....	43
Table IV. Categorical Analyses Comparing Clinical Categories of Baseline CBCL Scores on Weight and Diet.....	44

Pediatric obesity treatment in rural settings: Association between psychosocial functioning and health outcomes

Childhood overweight and obesity remain a highly prevalent problem in the United States. About 30% of children and adolescents are overweight with a BMI $\geq 85^{\text{th}}$ percentile and about 15% are obese with a BMI $\geq 95^{\text{th}}$ percentile on BMI-for-age/gender growth charts (Kuczmarski et al., 2002; Ogden, Carroll, Kit, & Flegal, 2012). In addition to an increased risk of health conditions such as high blood pressure, atherosclerosis, and type 2 diabetes mellitus (Must & Strauss, 1999), pediatric obesity is associated with negative psychological consequences. Research suggests that compared with normal weight children, children with overweight/obesity show higher scores as well as higher rates of clinically significant scores on measures of internalizing behavior problems such as depression, anxiety, social withdrawal, and somatization (Bell et al., 2007; Tiffin, Arnott, Moore, & Summerbell, 2011; Vila et al., 2004) and externalizing behavior problems such as delinquent and aggressive behaviors (Gibson et al., 2008). Additionally, higher scores on measures of adiposity, such as standardized BMI (BMI_z), are associated with a higher risk and severity of internalizing (Bell et al., 2007; Gibson et al., 2008) and externalizing symptoms (Eschenbeck, Kohlmann, Dudey, & Schurholz, 2009; Gibson et al., 2008). However, other studies present contrasting findings with no association between adiposity and internalizing symptoms (Brewis, 2003; Drukker, Wojciechowski, Feron, Mengelers, & Van Os, 2009; Marks, Shaikh, Hilty, & Cole, 2009; Merikangas, Mendola, Pastor, Reuben, & Cleary, 2012), or externalizing symptoms (Drukker et al., 2009; Renman, Engstrom, Silfverdal, & Aman, 1999). These contrasting findings may be due to the fact that these studies use community-based samples; research suggests that the associations between adiposity and internalizing/externalizing symptoms are more robust in clinical samples

compared with community samples (Braet, Mervielde, & Vandereycken, 1997; Wardle & Cooke, 2005).

In addition to weight-related effects on psychological functioning, a growing field of research is investigating whether diet quality is related to pediatric psychological functioning (O'Neil et al., 2014). Several studies have shown that children with high-quality diets report fewer internalizing (Jacka et al., 2011; Jacka, Rethon, Taylor, Berk, & Stansfeld, 2013; McMartin et al., 2013; Weng et al., 2012) and externalizing symptoms (Oddy et al., 2009), while children with low-quality diets report more internalizing (Jacka et al., 2013; Weng et al., 2012) and externalizing (Oddy et al., 2009; Oellingrath, Svendsen, & Hestetun, 2014; Robinson et al., 2011) symptoms. In studies investigating the consumption of specific types of foods, children with higher internalizing and externalizing symptoms report eating more foods high in fat and sugar (Robinson et al., 2011) and fewer fruits and vegetables (Renzaho, Kumanyika, & Tucker, 2011).

Children from rural areas are particularly vulnerable to experiencing overweight/obesity and inadequate nutrition. Compared to children in urban areas, children in rural areas are more likely to be obese (Davis, Bennett, Befort, & Nollen, 2011; Liu, Bennett, Harun, & Probst, 2008; Lutfiyya, Lipsky, Wisdom-Behounek, & Inpanbutr-Martinkus, 2007). Children from rural areas are also less likely to adhere to national nutrition recommendations (Johnson, Johnson, Wang, Smiciklas-Wright, & Guthrie, 1994), and more likely to consume more calories and calories from fat (Crooks, 2000; Liu et al., 2012), as well as more foods high in fat and sugar (Davis et al., 2011; Davis, James, Curtis, Felts, & Daley, 2008). Various barriers to a healthy lifestyle likely drive these disparities in rural children (Lutfiyya et al., 2007; Tai-Seale & Chandler, 2010). Rural children who are overweight/obese are more likely than urban

counterparts to live in poverty, have no health insurance, and not receive preventative healthcare (Liu et al., 2008; Lutfiyya et al., 2007). Rural children also have less access to school nursing services or other health education services (Heneghan & Malakoff, 1997; Leeper, Hullett, & Wang, 2001). Finally, rural children spend more time engaging in sedentary activities (Lutfiyya et al., 2007) and have less access to resources that promote physical activity such as physical education classes, sidewalks, and fitness centers (Bevans, Fitzpatrick, Sanchez, Riley, & Forrest, 2010; Hendryx, 1993).

Despite the increased risk of obesity and inadequate nutrition in rural children, very few studies of this population have investigated the relationship between psychological health and adiposity, and none have investigated the relationship between psychological health and diet. One study from a rural telepsychiatry clinic found that compared to children of a normal weight, children with overweight/obesity had higher rates of conduct disorder and higher rates of bipolar disorder and depression. However, these results were not statically significant and may not be generalizable to rural children who are not referred for psychiatric care (Marks et al., 2009). In another study, children from rural North Carolina recruited between the ages of 9–13 were followed for several years. By age 16, chronic obesity predicted depressive disorder in boys, and oppositional defiant disorder in boys and girls (Mustillo et al., 2003). Finally, one study of children with overweight/obesity participating in a rural weight management intervention found a high rate of disordered eating attitudes and unhealthy weight control behavior, which was in turn associated with poorer emotional health related quality of life (Gowey, Lim, Clifford, & Janicke, 2014).

To treat pediatric overweight/obesity, expert guidelines have recommended an intervention model with treatment stages that increase in intensity depending on treatment

response as well as co-occurring behavioral and medical risk factors (Barlow & Expert Committee, 2007). Active participation from family members is recommended at every treatment stage, which include structured physician visits focusing on improving eating and activity habits (Stage 1: *Prevention Plus*) to a more comprehensive intervention with a structured diet and physical activity program and a focus on behavior modification techniques such as self-monitoring and goal setting (Stage 3: *Comprehensive Multidisciplinary Intervention*). Comprehensive family-based interventions in particular have been extensively studied and have been consistently shown to be more effective for causing weight loss compared with standard-of-care or control interventions across several reviews and meta-analyses (Janicke et al., 2014; Oude Luttikhuis et al., 2009; Young, Northern, Lister, Drummond, & O'Brien, 2007).

Compared to the number of studies on weight-related outcomes of family-based pediatric obesity interventions, far fewer have investigated diet-related outcomes, and such research has shown mixed outcomes. One meta-analysis found family-based interventions to be no different than passive control groups in causing reductions in caloric intake from baseline to follow-up (Janicke et al., 2014). Conversely, other studies of nutritional outcomes in family-based interventions have found significant improvements in intake of fruits and vegetables (Epstein, Paluch, Kilanowski, & Raynor, 2004), total daily fat and sugar (Reinehr et al., 2010), and servings of foods high in fat and sugar, also commonly referred to as red foods (Davis, Daldalian, et al., 2013; Duffy & Spence, 1993; Epstein, McKenzie, Valoski, Klein, & Wing, 1994; Epstein, Paluch, Beecher, & Roemmich, 2008; Epstein et al., 2004).

Research on pediatric obesity interventions has also been insufficient in terms of investigating psychological outcomes. While several family-based interventions have produced

promising findings in which internalizing and externalizing symptoms improve from baseline to follow-up (Epstein, Paluch, Gordy, Saelens, & Ernst, 2000; Levine, Ringham, Kalarchian, Wisniewski, & Marcus, 2001; Munsch et al., 2008; M. D. Myers, Raynor, & Epstein, 1998; Sacher et al., 2010; Wadden et al., 1990), others have not found significant improvements in these symptoms or significant differences in symptom improvement between intervention and control groups (DeBar et al., 2012; McCallum et al., 2007). Furthermore, few studies of pediatric obesity interventions have investigated whether psychological functioning affects weight- and diet-related outcomes. Some research findings suggest that children with better psychological functioning at baseline are more successful in weight management programs (Goldschmidt et al., 2014; O'Brien, Smith, Bush, & Peleg, 1990), while others report no association between baseline psychological functioning and treatment success (Braet, 2006). Finally, limited research has investigated whether improvements in psychological functioning are related to improvements in child health outcomes over the course of pediatric obesity treatment. One study of an 8-month intervention found that greater decreases in percent overweight were associated with improvements in somatic complaints in both genders and improvements in overall behavior problems in girls. However, this study also found that boys who had greater decreases in percent overweight showed less improvement in externalizing symptoms (M. D. Myers et al., 1998). Other studies have found no association between changes in psychological health and intervention success (Levine et al., 2001; Wadden et al., 1990).

Despite research supporting the effectiveness of pediatric obesity treatment, rural areas are underrepresented in pediatric obesity treatment research, likely because of limited access to resources and well-trained experts (K. M. Myers, Valentine, & Melzer, 2007). For example, only three studies have investigated comprehensive family-based interventions targeting rural

children. One such study conducted at health education centers showed that participants of family-based interventions had significantly greater decreases in standardized BMI (BMI_z) from pre- to post-intervention compared with participants in a wait-list control group. Unfortunately, outcomes related to diet or psychological health were not reported (Janicke et al., 2008). The other two studies were from Davis and colleagues and investigated differences in health outcomes between a group intervention delivered via telemedicine (interactive televideo) and an alternative intervention, which was either a structured physician visit (Davis, Sampilo, Gallagher, Landrum, & Malone, 2013) or a group intervention delivered via telephone (Davis et al., 2015). In recent years, telemedicine interventions have improved access to obesity treatment for rural families, and studies of telemedicine obesity treatment for individual children and families have found better or comparable health outcomes compared to in-person clinics (Irby, Boles, Jordan, & Skelton, 2012; Lipana, Bindal, Nettiksimmons, & Shaikh, 2013; Mulgrew, Shaikh, & Nettiksimmons, 2011). In the studies of group-based interventions by Davis and colleagues, no significant differences in health outcomes were found between the telemedicine and alternative interventions. BMI_z scores either decreased (Davis, Sampilo, et al., 2013), or remained the same from pre- to post-intervention (Davis et al., 2015), and non-significant improvements were seen in diet and psychological functioning. When telemedicine and telephone groups from one study were combined (Davis et al., 2015), a significant improvement from pre- to post-intervention in internalizing, externalizing, and total behavior problems was found (Sporn, Davis, & Dean, 2014).

Current Study

The current study is a secondary analysis of data from two trials of rural family-based pediatric obesity interventions (Davis et al., 2015; Davis, Sampilo, et al., 2013) with an overall

objective to address gaps in the literature regarding the associations between psychological functioning and health outcomes related to weight and diet in rural children participating in such interventions. To address this objective, the current study examined (1) baseline associations between psychological functioning and weight/diet; (2) the relationship between baseline psychological functioning and changes in weight/diet; and (3) the relationship between changes in psychological functioning and changes in weight/diet. It was expected that poorer psychological functioning at baseline would be associated with higher BMIz and worse diet at baseline, as well as less improvement in BMIz and diet from pre- to post-intervention. It was also expected that less improvement in psychological functioning from baseline to post-intervention would be associated with less improvement in BMIz and diet.

Methods

Participants and Procedure

Participants in both studies were children ages 5–12 with overweight/obesity (BMI > 85th percentile) living in rural areas (a town or county with a population < 20,000). At least one parent or guardian participated in the study with each target child. Recruitment occurred in elementary schools across the rural Midwest, and written informed consent and assent were obtained from each parent/guardian and child participant respectively. In study 1, 57 children were randomized to receive either an 8-month family-based group intervention delivered using telemedicine technology (TM) or a standardized physician visit (PV). In study 2, 103 children were randomized to receive an 8-month family-based group intervention, delivered via telemedicine technology (TM) or telephone conference call (TP). See Table 1 for number of children in each intervention group. For the current study, only children ages 6–12 were included, as these are the valid ages for the Child Behavior Checklist/6–18, one of the primary

measures of interest. Therefore, a combined sample of 148 children from studies 1 and 2 were used for the current study.

Detailed information about the two studies' interventions is described elsewhere (Davis et al., 2015; Davis et al., 2013). In short, the PV intervention in study 1 represented an enhanced standard-of-care treatment in which children and families met with a primary care physician to discuss a standardized list of topics relevant to pediatric obesity. The TM interventions in studies 1 and 2 consisted of 8 weekly and 6 monthly sessions that covered behavior, nutrition and physical activity topics. Each session was held at participants' elementary schools and the primary study interventionist (a clinician with at least a Master's degree) led each session remotely via interactive televideo. The TP intervention in study 2 was equivalent to the TM intervention except the interventionist led each session remotely via conference call. Both studies were conducted with the approval of the University of Kansas Medical Center Institutional Review Board (IRB).

Measures

Measures were collected at two time points—pre-treatment baseline and post-treatment (approximately 8 months after baseline)—with the exception of demographics and maternal BMI, which were only collected at baseline.

Demographics. The target child's gender, age, grade level, race, ethnicity, and eligibility for receiving free or reduced lunch were collected, as well as information pertaining to maternal and paternal marital status, education status, occupation, and income level.

BMIz and maternal BMI. Height and weight were measured by school nurses via a Harpenden Holtain stadiometer, Model 603 (Holtain, Crymych, UK) and a portable SECA digital scale (SECA, Hamburg, Germany). Height and weight were calculated as the average of

three independent measurements and used (along with age and gender) to determine BMI_z, a standardized measure of adiposity commonly used in studies of pediatric obesity interventions (Janicke et al., 2008; Steele et al., 2012). Maternal height and weight were also measured using the stadiometer and scale and the standard formula was used to calculate adult BMI {[weight (lb) / height (in)²] x 703} for each mother.

The Child Behavior Checklist/6–18 (CBCL). The CBCL (Achenbach, 1991; Achenbach, Rescorla, & Maruish, 2004) is a standardized measure that assesses parental report of child competencies and behavioral or emotional problems. Three broadband scores (internalizing, externalizing, and total problems) were utilized in the current analyses. The internalizing problems score includes items from the anxious/depressed, withdrawn/depressed, and somatic complaints subscales. The externalizing problems score includes items from the rule-breaking and aggressive behavior problems subscales. The total problems score includes items from the previously mentioned subscales plus the social, thought, and attention problems subscales. Raw scores were converted to standardized *t*-scores based on norms for children aged 6–11 or 12–18. Higher scores are associated with more behavior problems and thus poorer psychological functioning. Established broadband score cut-offs indicating clinically significant symptoms include 60–63 for “borderline clinical” scores, and ≥ 64 for “clinical” scores (Achenbach et al., 2004). The CBCL has been shown to be a reliable and valid measure of psychological functioning; internal reliability estimates of all scale scores are .90 and all scales successfully discriminate between children referred and not referred for treatment for behavior problems (Achenbach et al., 2004).

24-hour dietary recall. The 24-hour diet recall is a standardized three-pass method, developed by the US Department of Agriculture for use in national dietary surveillance. This

measure has been shown to be a valid and reliable representation of a child's overall diet (Crawford, Obarzanek, Morrison, & Sabry, 1994). Trained Master's and PhD level researchers gathered dietary recall data over the phone. Prior to the phone call, parents were asked to sit with their child and write down all food items consumed on two weekdays and one weekend day at each time point. Parents completed the phone recalls regarding their child's diet for the three days using standardized procedures. All dietary data were analyzed using NDSR software version 2005 developed by the Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN, USA. For the current study, at each time point, servings of fruits and vegetables (FV) and servings of red foods (>12 grams of sugar and/or >7 grams of fat; Epstein & Squires, 1988) were assessed. FV and red foods were chosen based on prior studies that have used similar variables when assessing the association between diet and psychological functioning (Oddy et al., 2009; Renzaho et al., 2011; Robinson et al., 2011).

Data Analyses

Change scores created by subtracting baseline from post-intervention scores represented the magnitude of change in the variables of interest (BMIz, FV, red foods, and CBCL scores). Negative change scores for BMIz, CBCL, and red foods signified improvement via a reduction in weight, a decrease in number or severity of behavior problems, and a decrease in intake of red foods respectively. A positive change score for FV signified improvement via increased average daily consumption of FV. Two-tailed tests of significance were used for all analyses with $\alpha = .05$. Each analysis used all cases for which complete data was available.

Preliminary analyses across both studies found no differences in outcomes between TM in study 1, TM in study 2, and TP in study 2. Therefore, a dichotomous "treatment-type" variable was created with two levels: group treatment (TM and TP combined) and PV. In an

independent samples *t*-test, a significant difference in BMIz change was found between group treatment ($M = -0.005 \pm 0.20$) and PV ($M = -0.17 \pm 0.30$). Therefore, treatment type was used as a covariate for analyses utilizing change scores.

Frequencies, means, and standard deviations were calculated for descriptive purposes, and within-sample *t*-tests were run across the entire sample to assess for significant changes in CBCL and health variables (BMIz, FV, and red foods) from pre- to post-intervention. To determine bivariate associations, Pearson product-moment correlations were computed among CBCL baseline and change scores, health variables baseline and change scores, as well as treatment type and other covariates that were chosen based on previous research including gender (Golley, Magarey, Baur, Steinbeck, & Daniels, 2007), age (Danielsson, Kowalski, Ekblom, & Marcus, 2012), child eligibility for a free or reduced price school lunch (Lee, 2012), and maternal BMI (Zeller et al., 2007).

Hierarchical multiple regression analyses were also conducted to test how CBCL scores were related to health variables (BMIz, FV, and red foods), adjusting for covariates. For each model, covariates were entered in step 1, and CBCL scores were entered in step 2. All models included age, gender, free/reduced lunch eligibility, and maternal BMI as covariates, and models with change scores as the outcome variables also included treatment type. First, to examine baseline associations between psychological functioning and weight/diet, two regression models were run with each of the three baseline health variables as outcomes: one with both CBCL internalizing and externalizing scores and one with only CBCL total scores entered in step 2. Similarly, to assess the relationship between baseline psychological functioning and change in weight/diet, two regression models were run with each of the three health variable change scores as outcomes: one with both CBCL internalizing and externalizing

scores and one with only CBCL total scores entered in step 2. Finally, to assess the relationship between change in CBCL scores and change in weight/diet, two regression models were run with each of the three health variable change scores as outcomes: one with both CBCL internalizing and externalizing scores and one with only CBCL total scores entered in step 2.

While conducting initial analyses, the residuals for the models predicting baseline FV and red foods were found to be highly positively skewed, violating the assumption of normally distributed residuals. A log transformation of baseline FV and a square root transformation of baseline red foods achieved normality in the distribution of these variables. When these regression models were rerun, the assumption of normally distributed residuals was met. Correlational analyses were also rerun with these transformed variables.

Categorical analyses were also run using descriptive statistics and independent samples *t*-tests to determine whether children with baseline CBCL scores in the borderline and clinical range (≥ 60 ; simply called “clinical” for the purpose of this study) displayed different outcomes in terms of baseline and change in weight/diet compared with children whose baseline CBCL scores were in the subclinical range (< 60). Exploratory categorical analyses were also conducted to determine whether categories of change in CBCL scores (total only) predicted degree of change in BMI_z. Children were categorized based on whether their CBCL total scores were 1) subclinical at baseline and follow-up, 2) clinical at baseline and follow-up, 3) subclinical at baseline and clinical at follow-up, and 4) clinical at baseline and subclinical at follow-up. To account for random error, a reliable change index (RCI) score was calculated to determine the degree of change in total score that was necessary to be considered valid (Jacobson & Truax, 1991). Based on the RCI calculation, a magnitude of change in CBCL total score of at least ± 4.68 was necessary for a post-intervention change in clinical category to be

considered valid. Because of the vast differences in sample size between the four categories of change (described in results), only descriptive analyses were conducted.

Results

Descriptives

Table I lists the characteristics of the sample. Representing the population from which they were drawn, a large majority identified as white or part-white (91.9%) and a sizeable portion of children were eligible for free or reduced lunch (38.5%). The majority of participants' mothers were married (70.9%) with at least a college level education (71.0%), and average maternal BMI was within the obese range (>30).

Table II lists sample characteristics related to psychological functioning, weight, and diet. Mean CBCL internalizing, externalizing, and total scores were in the subclinical range at baseline and showed a statistically significant decrease at follow-up ($ps < .001$). The Cohen's d effect sizes for these changes in CBCL scores were in the small to moderate range (from $d = 0.36$ to $d = 0.44$). The majority of participants were in the subclinical category for internalizing, externalizing, and total CBCL scores at baseline (75.7–81.1%) and this percentage increased at 8 months (83.2–88.2%). Average BMIz at baseline ($M = 1.75 \pm 0.46$) and 8 months ($M = 1.72 \pm 0.50$) were in the obese range ($>95^{\text{th}}$ percentile) and pre- to post-intervention changes in BMIz was not significant ($M = -0.03 \pm 0.23$, $n = 131$). Consumption of FV was similar between baseline ($M = 3.78 \pm 1.90$) and 8 months ($M = 3.71 \pm 1.59$), and increase in FV during the intervention was not significant ($M = 0.03 \pm 1.87$, $n = 111$). Finally, a decrease in red foods was seen between baseline ($M = 6.93 \pm 2.52$) and 8 months ($M = 6.01 \pm 2.36$), and this decrease in red foods ($M = -0.63 \pm 2.35$, $n = 110$) was statistically significant, $t(109) = 2.83$, $p < .01$, with a small effect size ($d = 0.27$).

Correlational Analyses

Among baseline variables, no significant bivariate correlations emerged between CBCL scores and BMIz, FV, or red foods. A significant correlation was noted between gender and red foods (square root transformed, $r_{pb} = -.23, p < .01$) in which males ate more red foods per day at baseline ($M = 7.50 \pm 2.78$) than females ($M = 6.27 \pm 2.01$). Maternal BMI was also significantly correlated with BMIz and FV in that higher maternal BMI was associated with higher BMIz ($r = .30, p < .01$) and lower FV (log transformed, $r = -.22, p < .01$) at baseline.

Neither baseline CBCL scores nor change in CBCL scores was significantly correlated with change scores in health variables. However, a significant positive relationship emerged between age and change in CBCL internalizing ($r = .22, p < .05$), externalizing ($r = .24, p < .01$), and total ($r = .27, p < .01$) scores. In other words, as age increased, CBCL scores were more likely to worsen from baseline to follow-up. Additionally, a significant positive relationship between maternal BMI and FV change ($r = .22, p < .05$) indicated that higher maternal BMI was related to greater increases in FV from baseline to follow-up (despite the negative association between these variables at baseline). A significant positive correlation also emerged between change in red foods and change in BMIz ($r = .19, p < .05$) such that increasing red foods was associated with increasing BMIz scores.

Regression Analyses

2-step hierarchical regression models were run to determine whether baseline CBCL scores predicted baseline health variables (BMIz, log transformed FV, and square root transformed red foods), as well as and change in health variables (BMIz, FV, and red foods). Table III presents the results of the hierarchical regression models with the first step including

the chosen covariates and the second step including CBCL internalizing and externalizing scores.

In terms of baseline health variables, the step 1 models were only significant in predicting BMIz scores ($p < .01$) and log transformed FV ($p < .05$), and approached significance for predicting square root transformed red foods ($p = .053$). Maternal BMI was a significant predictor of BMIz ($\beta = .29, p < .001$) and log transformed FV ($\beta = -.23, p < .01$), while gender was a significant predictor of square root transformed red foods ($\beta = -.23, p < .01$). When baseline CBCL internalizing and externalizing scores were entered in the second step to predict BMIz, the overall model remained significant ($p < .01$). While the increase in the amount of variance explained by the CBCL scores was not significant ($\Delta R^2 = .02, p = .16$), internalizing scores approached significance as an independent predictor ($\beta = .19, p = .056$) and maternal BMI continued to be a significant predictor ($\beta = .30, p < .001$). In other words, higher maternal BMI predicted higher BMIz and there was a trend towards higher internalizing CBCL scores predicting higher BMIz scores. Unlike with BMIz, the overall model for predicting log transformed FV became non-significant when CBCL scores were entered ($p = .065$), although maternal BMI remained a significant predictor ($\beta = -.23, p < .01$) such that higher maternal BMI was associated with a lower FV consumption. Finally, when CBCL internalizing and externalizing scores were added to the model predicting square root transformed red foods, the overall model became significant ($p < .05$), the amount of variance explained by the addition of CBCL scores approached significance ($\Delta R^2 = .042, p = .055$), and both gender ($\beta = -.25, p < .01$) and CBCL externalizing scores ($\beta = .25, p < .05$) were significant predictors. In other words, being male and having worse externalizing symptoms was associated with higher consumption of red foods.

With changes in health indicators as the outcome variables, none of the step 1 models (including gender, age, free/reduced lunch eligibility, maternal BMI, and treatment type) were significant. The addition of baseline CBCL internalizing and externalizing scores in the second step did not add a significant amount of variance to any of the models, and the overall models remained non-significant. However, maternal BMI ($\beta = .18, p < .05$) and treatment type ($\beta = .19, p < .05$) made significant contributions to the model predicting BMIz change such that higher maternal BMI and being assigned to a group treatment condition was associated with less weight loss success pre- to post-intervention. Additionally, maternal BMI made a significant contribution to predicting change in FV ($\beta = .23, p < .05$) such that higher maternal BMI was associated with children greater increases in FV intake from pre- to post-intervention. Similarly, the addition of CBCL internalizing and externalizing change scores in the second step did not add a significant amount of variance to any of the models, nor were any of the overall models significant. The only coefficient in any of these models that was significant was maternal BMI ($\beta = .25, p < .05$) predicting change in FV; similarly to the model with baseline CBCL internalizing and externalizing scores, higher maternal BMI predicted greater increases in FV intake.

For all models, when CBCL total score was added as the second step instead of CBCL internalizing and externalizing scores, CBCL total scores did not account for a significant amount of added variance for any of the models, and never trended towards or emerged as a significant independent predictor of any of the health variables ($ps > .10$). There were no changes in the direction or magnitude of the findings compared to models that included internalizing and externalizing symptoms, except that when predicting baseline square root transformed red foods; the model with baseline CBCL internalizing and externalizing was

significant ($p < .05$), while the model with baseline CBCL total scores was not, $F(5, 128) = 2.08, p = .07$.

Categorical Analyses

Results of categorical analyses comparing baseline clinical and subclinical CBCL scores on health outcomes (baseline and change) are presented in Table IV. A statistically significant difference emerged in which children with clinical internalizing scores ($M = 1.90 \pm 0.49$) had significantly higher baseline BMIz compared to children with subclinical internalizing scores ($M = 1.70 \pm 0.44$), $t(145) = 2.30, p < .05$. Cohen's effect size value ($d = .43$) suggested a small to medium difference. Similarly, children with clinical CBCL total scores ($M = 1.87 \pm 0.47$) had higher baseline BMIz compared with subclinical total scores ($M = 1.87 \pm 0.47$). This difference trended towards significance ($p = .09$) with a small effect size ($d = .35$). No differences between children with clinical versus subclinical baseline internalizing scores were found on change in BMIz from pre- to post-intervention. However, children with subclinical CBCL total and externalizing scores at baseline showed slight decreases in BMIz, while children with clinical CBCL total and externalizing scores showed slight increases. Although neither difference was statistically significant, effect sizes ($d = 0.30$ and $d = 0.39$) indicate a small difference between these two groups.

Regarding baseline FV consumption, no differences emerged between subclinical and clinical CBCL scores. Regarding FV change, however, a higher pre- to post-intervention increase in FV intake was noted in children with subclinical internalizing scores ($M = 0.17 \pm 2.15$) compared with children with clinical internalizing scores ($M = -0.06 \pm 1.82$), and this difference, although not statistically significant, showed a small effect size ($d = .26$). While assessing baseline red food consumption, a statically significant difference emerged among

externalizing scores in which children with clinical baseline externalizing scores ($M = 8.03 \pm 2.07$) ate significantly more servings of red foods compared to children with subclinical scores ($M = 6.66 \pm 2.31$), $t(139) = 2.63$, $p < .05$. Cohen's effect size value ($d = .50$) indicates a moderate difference between these two groups. Similarly, children with clinical CBCL total scores ($M = 7.43 \pm 2.70$) ate more servings of red foods compared with those subclinical total scores ($M = 6.79 \pm 2.47$). This difference was not statistically significant and displayed a small effect size ($d = .25$). When post-intervention changes in red foods were assessed between baseline clinical versus subclinical CBCL scores, a different pattern emerged in which children with clinical CBCL scores decreased their red food consumption to a greater degree than children with subclinical scores. However, only in externalizing scores did the greater decrease in red foods between children with clinical ($M = -1.47 \pm 2.15$) versus subclinical scores ($M = -0.47 \pm 2.37$) trend towards statistical significance ($p < .10$) with a small to moderate effect size ($d = .44$).

When categorizing children by pattern of change in CBCL total scores, the majority of children were subclinical at baseline and remained subclinical at follow-up ($n = 92$, 79.3%). Far fewer children had scores that were clinical at baseline and follow-up ($n = 16$, 13.8%) or scores that were clinical at baseline and subclinical at follow-up ($n = 8$, 6.9%). No children had subclinical scores at baseline that became clinical at follow-up. Two of these categories showed slight decreases in BMIz from baseline to follow-up: children who had subclinical CBCL scores at baseline and follow-up ($M = -0.05 \pm 0.23$), as well as children who changed from clinical to subclinical from baseline to follow-up ($M = -0.04 \pm 0.14$, respectively). Conversely, children who had clinical scores at baseline and follow-up showed a slight increase in BMIz ($M = 0.08 \pm 0.27$). Although statistical significance was not tested, the effect sizes of the differences

between the children who had consistently clinical symptoms compared with the children who remained or became subclinical were large ($d = .80$ and $d = 1.08$ respectively).

Discussion

The overall aim of the current study was to assess whether psychological functioning in terms of internalizing, externalizing, and total behavior problems influenced health outcomes related to weight (BMIz) and diet (FV and red foods) in rural children participating in family-based pediatric obesity interventions. To address this aim, analyses focused on (1) baseline associations between psychological functioning and weight/diet; (2) the relationship between baseline psychological functioning and pre- to post-intervention changes in weight/diet; and (3) the relationship between pre- to post-intervention changes in psychological functioning and pre- to post-intervention changes in weight/diet.

Baseline Associations between Psychological Functioning and Weight/Diet

Focusing on baseline associations between psychological functioning and weight, findings revealed a linear trend that approached significance in which greater severity of internalizing symptoms was associated with higher BMIz at baseline. This finding is consistent with previous studies in urban children that also included children with a normal weight (Bell et al., 2007; Gibson et al., 2008). However, other studies of children with overweight/obesity have found either no relationship between severity of overweight/obesity and severity of internalizing symptoms (Epstein, Myers, & Anderson, 1996; Favaro & Santonastaso, 1995) or a relationship in the opposite direction, with higher weight associated with a lower risk of the internalizing symptom depression (Vila et al., 2004). Comparatively, the current study's findings indicate that in rural children, increasing BMIz—even if it within the same weight category—is associated with increasing severity of internalizing symptoms. This linear relationship was

corroborated by the fact that children with clinically significant internalizing symptoms had a significantly higher BMIz at baseline compared with children with subclinical symptoms. Findings also suggested a trend in which children with clinically significant total behavior problems had a higher baseline BMIz compared with children without such problems. Additional research is needed to determine whether internalizing symptoms primarily contributed to this difference in BMIz between rural children with and without clinically significant total behavior problems or whether other types of behavioral issues also played a role. Although current results do not support an association between externalizing symptoms and BMIz, other behavioral problems may influence differences in BMIz among rural children, including peer relationship difficulties and attention problems. In fact, previous findings with urban samples have indicated a significant relationship between severity of social problems (Drukker et al., 2009; Vila et al., 2004) or attention problems (Erhart et al., 2012; Eschenbeck et al., 2009) and weight or adiposity.

It is important to note that despite the association between clinically significant behavior problems and BMIz, the majority of children in the current study did not show such behavior problems. However, findings do suggest that children with clinically significant behavior problems have a higher BMIz when compared to their counterparts with subclinical symptoms. Previous research proposes several mechanisms explaining the link between weight and behavior problems. Biologically, hormones that regulate emotion also play a role in influencing hunger, satiety, and weight gain (Goossens, Braet, Van Vlierberghe, & Mels, 2009; Maxwell & Cole, 2009). Environmental factors may also play a role. For instance, prior research suggests that stress and depression are higher among parents with lower socioeconomic status (SES), which in turn limits their ability to provide emotional support and positive role modeling, and

leads to increased risk of behavior problems and obesity among their children and adolescents (Schreier & Chen, 2013). Although eligibility for free or reduced lunch was not correlated with behavior problems or BMIz, the role of other aspects of SES such as income or parental education level should be examined. Levels of parental stress and depression should also be examined.

Findings regarding baseline associations between psychological functioning and diet revealed that a greater severity of externalizing symptoms was significantly associated with higher consumption of red foods. Similarly, children with clinically significant externalizing symptoms consumed significantly more servings of red foods compared to children with subclinical symptoms. This positive association between red foods and severity of externalizing symptoms is consistent with studies of urban children that did not take weight status into account (Oddy et al., 2009; Oellingrath et al., 2014; Robinson et al., 2011), and suggests that the relationship between externalizing symptoms and high fat/sugar foods is salient even in a specific population of rural children with overweight or obesity. Conversely, the current study did not find any differences in red food consumption between subclinical and clinical levels of internalizing symptoms. This finding is inconsistent with previous research that reports a positive relationship between internalizing symptoms and red food intake (Jacka et al., 2011; Robinson et al., 2011; Weng et al., 2012). However, additional research is needed with normal weight children to determine whether red foods predict differences in internalizing symptoms between rural children who are normal weight and rural children who are overweight or obese. Finally, unlike with red foods, no meaningful associations between FV intake and psychological functioning at baseline were found. Previous research with urban children has found that greater emotional symptoms (e.g., sadness, worry, etc.) were associated with consuming fewer servings

of fruits, while greater emotional symptoms in girls (but not boys) were associated with consuming fewer servings of vegetables. In this same study, no associations were found between conduct problems and FV consumption but a higher degree of pro-social behavior was associated with consuming more FV (Renzaho et al., 2011). Given these prior findings, further research is needed to determine whether a relationship between behavior problems and FV consumption exists when interaction with gender is assessed or when more specific measures of behavior problems are used, such as pro-social behavior.

Relationship between Baseline Psychological Functioning and Changes in Weight/Diet

Although findings did not indicate a linear relationship between psychological functioning and BMIz, categorical comparisons revealed non-significant, yet meaningful differences (in terms of effect sizes) between children with and without clinically significant behavior problems at baseline. Specifically, children with clinical levels of externalizing and total behavior problems at baseline were less successful in terms of weight loss compared with children who had subclinical levels of these behavior problems. Prior research of pediatric obesity interventions for urban children has shown mixed results when examining whether baseline psychological functioning is related to weight management success. Similarly to the current study, significant findings may be more likely to emerge when categorical associations are examined (as opposed to continuous). For example, one study of an inpatient pediatric obesity treatment found that while baseline eating disorder symptomatology predicted worse weight loss outcomes, internalizing and externalizing symptoms did not (Braet, 2006). Conversely, another study found that children with fewer total behavior problems (-1 SD of total CBCL score) were more successful at preventing weight gain than children with more behavior problems ($+1$ SD of total CBCL score) during the maintenance phase of a family-

based weight management program (Goldschmidt et al., 2014). These previous findings corroborate with current findings and suggest that prior to the start of a pediatric obesity intervention, rural children should be assessed for psychological problems and categorized based on score cut-offs. This would allow children who are less likely to benefit from a standard pediatric obesity treatment due to psychological issues to receive more intensive or alternative treatments. For example, in the current study, clinically significant scores on externalizing symptoms—which indicate the presence of rule-breaking and aggressive behaviors—may have prevented children from making the behavior changes necessary to activate weight loss. Further research is needed to determine whether assessing for and treating externalizing behavior problems before or soon after starting a weight management intervention could lead to greater weight loss and more dietary changes.

As with weight-related findings, no significant linear relationships were found between baseline psychological functioning and post-intervention changes in diet. However, categorical analyses revealed a trend in which greater increases in FV intake were found in children with subclinical internalizing symptoms compared with children with clinical internalizing symptoms. Although not statistically significant in the current sample, the effect size of this trend revealed a meaningful difference and suggests that rural children with fewer internalizing symptoms may be more receptive to increasing consumption of fruits and vegetables during a pediatric obesity intervention. Nevertheless, it is important to note that average fruit and vegetable consumption at baseline and post-intervention within the current sample was low, falling below expert recommendations of five servings per day (Ahmed & Blumberg, 2009). In fact, even among children who were psychologically healthy at baseline, improvement in fruit and vegetable consumption during the intervention was not enough for average daily

consumption to exceed five servings. Therefore, the current study's findings suggest that additional work is needed to identify factors associated with fruit and vegetable intake in rural children.

Study findings also revealed that across the entire sample, consumption of red foods significantly declined. Unexpectedly, greater decreases in red food intake were found in children with clinically significant externalizing and total behavior problems at baseline compared to children with subclinical symptoms. Although this finding could conceivably be due to regression towards the mean, an alternative possibility is that parents who reported more behavior problems in their child may have believed that consumption of high fat/sugar foods contributed to their child's behavior problems. Therefore, these parents may have been more motivated to help their child improve their diet. Conversely, clinically significant internalizing symptoms at baseline were not associated with greater decreases in intake of red foods, possibly because internalizing symptoms are less disruptive to others and are less likely to be attributed to unhealthy foods. Future research should assess the extent to which rural parents believe that their child's diet contributes to their behavior problems and determine whether this predicts post-intervention improvements in diet. It is also important to note that despite increases in red food intake pre- to post-intervention, at both time points children on average were eating between six and seven servings of red foods per day. In contrast, the meal plan taught during the telemedicine and telephone interventions recommends no more than four red foods a week (Epstein & Squires, 1988). Rural children face various unique barriers that increase the risk of poor nutrition overall (Tai-Seale & Chandler, 2010), and current results regarding red foods as well as fruit and vegetable consumption suggest that more intensive interventions are needed to improve dietary intake among rural children with overweight/obesity.

Relationship between Changes in Psychological Functioning and Weight/Diet Change

No continuous associations were found between changes in behavior problems and changes in BMIz or diet. Research has been mixed in terms of whether psychological changes during interventions affect changes in weight-related outcomes. For example, studies of family-based pediatric obesity programs have found that improvement in internalizing symptoms was not associated with weight change pre- to post-intervention (Levine et al., 2001; Wadden et al., 1990). In another study, a decrease in percent overweight accounted for improvement in internalizing problems related to somatic complaints as well as improvement in overall behavior problems in girls only (M. D. Myers et al., 1998). However, no association was found between decrease in percent overweight and internalizing symptoms overall, and boys with greater reductions in percent overweight showed less improvement in externalizing problems. Based on these findings in urban children, further research with rural children is needed that examines how gender interacts with the relationship between pre- to post-intervention changes in psychological symptoms and changes in health outcomes. Future research should also investigate whether pre- to post-intervention changes in health outcomes are predicted by other aspects of psychological functioning such as eating disorder symptomatology and somatic symptoms. Examining eating disorder symptomatology may be particularly useful based on the results from one study of rural children participating in a family-based obesity intervention. Specifically, these children reported high rates of disordered eating attitudes and unhealthy weight-control behaviors, and these symptoms were associated with worse overall and emotional HRQOL (Gowey et al., 2014).

Finally, categorical analyses indicated that children whose total behavior problems were clinical at baseline and follow-up had worse weight-loss outcomes compared to children whose

total behavior problems either stayed subclinical pre- to post-intervention or improved from clinical to subclinical. Although statistical significance could not be established, the effect sizes of the differences between these groups were large to very large. This finding suggests that providing psychological support to rural children with clinically significant behavior problems prior to and while participating in pediatric obesity interventions may maximize weight loss outcomes, particularly if their symptoms could be improved to a subclinical level. Ultimately, additional research with larger samples from rural and urban areas is needed to determine whether this pattern of results replicates and is statistically significant.

Limitations

Several limitations are important to note. First, the sample size was small considering the number of variables included in regression models and the study may not have been powered identify all meaningful continuous and categorical associations. In particular, many effect sizes of the differences in health outcomes between children with and without clinical behavior problems were small to medium, indicating the possibility that with a larger sample size, statistically significant differences may have emerged. Sample sizes within certain analyses were also limited due to different patterns of missing data, which were not a result of participant drop out. Specifically, a low percentage of participants (8.1%) either dropped out or were considered “non-completers” (attended <50% of intervention sessions). However, because some data needed to be collected over the phone (dietary recalls) or by mail (CBCL), much of the data was simply missing due to logistical issues such as participants not responding to phone calls or forgetting to return surveys.

Furthermore, because of limited sample sizes, analyses to determine whether particular variables moderated or mediated the relationships between psychological functioning and

weight/diet were not conducted. For example, correlational analyses in the current study found a notable association between age and change in psychological functioning in the current sample such that as age increased, behavior problems were more likely to worsen from baseline to post-intervention. This may be because older children are more acutely aware of their weight than younger children and are more likely to feel shame or embarrassment or act out in negative ways in reaction to being in a program targeting their weight. As previous studies have found that older children are less likely to respond to pediatric obesity interventions than younger children (Eschenbeck et al., 2009), future research should investigate whether an increase in behavioral symptoms may be a main mechanism by which this age difference exists in rural children participating in pediatric obesity interventions. However, it should also be noted that categorical analyses indicated that no children went from having subclinical to clinical total behavior problems, so these increases in behavior problems by age may not be clinically meaningful. Future research should utilize larger sample sizes to incorporate analyses of interactions.

Finally, although reflective of the rural Midwest, the current study's sample was predominantly white, and thus findings may not replicate in more diverse samples. Additionally, maternal education level was relatively high in the current sample, likely because many of the child participants were children of teachers and faculty within the elementary schools where the interventions were delivered. Perhaps because of the high education levels, the percentage of children with eligibility for free or reduced lunch was relatively low (38.5%) compared to the average rate for rural counties in Kansas (~51%; The Annie E. Casey Foundation, 2015). Therefore, results of the current study may not replicate in rural areas with higher levels of poverty and lower levels of parental education.

Conclusions and Future Directions

The current study adds to the literature as few previous studies have investigated the association between psychological functioning and weight/diet in rural children specifically, particularly within the context of pediatric obesity interventions. Furthermore, few studies of pediatric obesity interventions within any pediatric population have investigated whether psychological functioning before and during the intervention influences health outcomes, and none has done so with a sample of rural children only. Several baseline findings support the fact that psychological functioning, particularly in regards to internalizing and externalizing symptoms, may predict various health outcomes in rural children, especially BMIz and red foods respectively. Additionally, associations between psychological functioning and changes in health outcomes suggest that assessing rural children for psychological programs may help predict which children are more successful in terms of weight loss and dietary changes in a family-based pediatric obesity intervention. However, additional research is needed with longer term follow-up, inclusion of normal weight children to better assess continuous relationships between psychological functioning and health outcomes, and inclusion of urban samples to compare findings and better inform how interventions could be adapted depending on which population is being targeted.

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Table I. Descriptives: Sample characteristics (N = 148)

	M ± SD or n (%)
Female gender	68 (45.9)
Age (years)	9.35 ± 1.54
Race/Ethnicity ^a	
White	136 (91.9)
Hispanic/Latino	11 (7.4)
Native American	8 (5.4)
Black	5 (3.4)
Asian/Pacific Islander	1 (0.7)
Maternal education level	
Some high school	8 (5.4)
High school graduate or equivalent	23 (15.5)
Vocational degree	11 (7.4)
Some college	34 (23.0)
Associates degree	17 (11.5)
Bachelor's degree	42 (28.4)
Graduate degree	12 (8.1)
Maternal marital status	
Married	105 (70.9)
Separated/Divorced	24 (16.2)
Single	18 (12.2)
Eligible for free/reduced lunch	57 (38.5)
Sample Size	
Study 1	52 (35.1)
Study 2	96 (64.9)
Group assignment	
Study 1 – Telemedicine	28 (18.9)
Study 1 – Physician Visit	24 (16.2)
Study 2 – Telemedicine	40 (27.0)
Study 2 – Telephone	56 (37.8)
Maternal baseline BMI	30.39 ± 7.76

Note. BMI = Body Mass Index.

^aPercentages reflect the fact that children could be identified as having more than one race/ethnicity.

Table II. Descriptives: Psychological Functioning, Weight, and Diet

	Baseline			8 month			Change	
	N (%)	M (SD)	Min-Max	N (%)	M (SD)	Min-Max	M (SD) ^a	% Change
Total CBCL		51.76 (9.75)	24–73		48.76 (9.94)	27–76	-2.82 (6.73) ^{***}	
Subclinical	117 (79.1)			104 (87.4)				8.3
Borderline	12 (8.1)			6 (5.0)				-3.1
Clinical	19 (12.8)			9 (7.6)				-5.2
Internalizing CBCL		51.99 (10.00)	33–75		49.10 (10.38)	33–75	-3.07 (8.70) ^{***}	
Subclinical	112 (75.7)			99 (83.2)				-7.5
Borderline	19 (12.8)			10 (8.4)				-4.4
Clinical	17 (11.5)			10 (8.4)				-3.1
Externalizing CBCL		51.71 (8.85)	33–73		48.63 (9.05)	33–76	-3.01 (6.92) ^{***}	
Subclinical	120 (81.1)			105 (88.2)				7.1
Borderline	13 (8.8)			6 (5.0)				-3.8
Clinical	15 (10.1)			8 (6.7)				-3.4
BMIz ^b		1.75 (0.46)	1.03–2.81		1.72 (0.50)	0.51–2.76	-0.03 (0.23)	
Overweight	64 (43.2)			55 (41.7)				-1.5
Obese	66 (44.6)			63 (47.7)				-4.5
Very obese	18 (12.2)			14 (10.6)				-1.6
FV servings per day		3.78 (1.90)	0.59–10.81		3.71 (1.59)	0.20–8.57	0.03 (1.87)	
Red food servings per day		6.93 (2.52)	1.55–14.72		6.01 (2.36)	1.62–13.35	-0.63 (2.35) ^{**}	

†p<.10; *p<.05; **p<.01; ***p<.001.

Note. CBCL = Child Behavior Checklist; BMIz = Body mass index z-score; FV = Fruits and Vegetables; Red foods = >12 g sugar, >7 g fat

^aReflects changes in scores from baseline to follow-up in participants with complete follow-up data

Table III. Hierarchical Regression Analyses Testing Effects of Internalizing and Externalizing Symptoms^a on Weight and Diet Outcomes

Variable	BL BMIz				BL Fruits/Vegetables per Day ^b				BL Red Foods per Day ^c			
	B(SE)	β	R ²	ΔR^2	B(SE)	β	R ²	ΔR^2	B(SE)	β	R ²	ΔR^2
Step 1												
Gender			.11	.11**			.07	.07*			.07	.07†
Age	-.11(.08)	-.11			.05(.04)	.10			-.24(.08)	-.25**		
Free/Reduced Lunch	-.01(.02)	-.04			-.01(.01)	-.08			.04(.03)	.13		
Maternal BMI	.03(.08)	.03			.04(.04)	.09			-.01(.08)	-.01		
	.02(.01)	.30***			-.01(.00)	-.23**			.00(.01)	.00		
Step 2												
BL CBCL Internalizing	.01(.01)	.19†	.14	.02	.00(.00)	.16	.09	.02	-.01(.01)	-.17	.11	.04†
BL CBCL Externalizing	-.01(.01)	-.09			-.00(.00)	-.09			.01(.01)	.25*		
Overall Model F(6, 127) = 2.04†												
Overall Model F(6, 127) = 2.64*												
Variable	Δ BMIz				Δ Fruits/Vegetables per Day				Δ Red Foods per Day			
	B(SE)	β	R ²	ΔR^2	B(SE)	β	R ²	ΔR^2	B(SE)	β	R ²	ΔR^2
Overall Model F(7, 117) = 1.49												
Overall Model F(7, 100) = 1.26												
Overall Model F(7, 98) = 0.34												
Step 1												
Gender			.08†				.06				.02	
Age	.02(.04)	.05			-.22(.42)	-.05			.40(.49)	.09		
Free/Reduced Lunch	.00(.01)	.00			.02(.14)	.01			.13(.16)	.09		
Maternal BMI	.03(.04)	.07			-.46(.42)	-.11			-.27(.50)	-.05		
Treatment Type	.01(.00)	.18*			.06(.03)	.23*			-.01(.03)	-.03		
	.12(.06)	.19*			-.13(.60)	-.02			-.18(.74)	-.03		
Step 2												
BL CBCL Internalizing	.00(.00)	-.02	.08	.00	-.04(.03)	-.18	.08	.02	-.02(.03)	-.09	.02	.01
BL CBCL Externalizing	.00(.00)	-.01			.01(.03)	.06			.02(.04)	.06		
Overall Model F(7, 103) = 1.17												
Overall Model F(7, 92) = 0.96												
Overall Model F(7, 90) = 0.22												
Variable	Δ BMIz				Δ Fruits/Vegetables per Day				Δ Red Foods per Day			
	B(SE)	β	R ²	ΔR^2	B(SE)	β	R ²	ΔR^2	B(SE)	β	R ²	ΔR^2
Step 1												
Gender			.07				.06				.02	
Age	.02(.04)	.05			-.19(.45)	-.04			.39(.52)	.08		
Free/Reduced Lunch	.00(.02)	.01			.00(.15)	.00			.09(.17)	.05		
Maternal BMI	.02(.04)	.04			-.34(.44)	-.08			-.21(.52)	-.04		
Treatment Type	.01(.00)	.17†			.07(.03)	.25*			-.01(.03)	-.05		
	.12(.06)	.19†			-.14(.62)	-.02			-.21(.75)	-.03		
Step 2												
BL CBCL Internalizing	-.00(.00)	-.03	.07	.00	.00(.03)	.00	.07	.01	.01(.03)	.02	.02	.00
BL CBCL Externalizing	.00(.00)	.06			-.02(.04)	-.07			.01(.04)	.03		

†p<.10; *p<.05; **p<.01; ***p<.001.

Note. CBCL = Child Behavior Checklist; BL = Baseline; Δ = change in scores from baseline to follow-up^aAnalyses with measure of total symptoms (CBCL total) are not included due to lack of significant findings.^bBaseline FV log transformed^cBaseline red foods square-root transformed

Table IV. Categorical Analyses Comparing Clinical Categories of Baseline CBCL Scores and on Weight and Diet (baseline and pre- to post treatment)

	BMIz				Fruit / Vegetable Servings per Day				Red Food Servings per Day			
	Baseline		Change		Baseline		Change		Baseline		Change	
	n (%)	M (SD)	n (%)	M (SD)	n (%)	M (SD)	n (%)	M (SD)	n (%)	M (SD)	n (%)	M (SD)
Total CBCL												
Subclinical	116 (78.9)	1.71 (0.45) [†]	106 (80.9)	-0.05 (0.22)	110 (48.0)	3.79 (1.97)	89 (79.5)	0.17 (2.15)	110 (78.0)	6.79 (2.47)	88 (80.0)	-0.57 (2.35)
Clinical	31 (21.1)	1.87 (0.47) [†]	25 (19.1)	0.04 (0.24)	31 (22.0)	3.74 (1.65)	23 (20.5)	-0.06 (1.82)	31 (22.0)	7.43 (2.70)	22 (20.0)	-0.91 (2.41)
Internalizing CBCL												
Subclinical	112 (76.2)	1.70 (0.44) [*]	103 (78.6)	-0.03 (0.21)	105 (74.5)	3.83 (2.03)	88 (78.6)	0.23 (2.12)	105 (74.5)	7.01 (2.61)	88 (78.6)	-0.65 (2.44)
Clinical	35 (23.8)	1.90 (0.49) [*]	28 (21.4)	-0.03 (0.29)	36 (25.5)	3.63 (1.45)	24 (21.4)	-0.30 (1.91)	36 (25.5)	6.72 (2.29)	24 (21.4)	-0.59 (2.03)
Externalizing CBCL												
Subclinical	119 (81.0)	1.74 (0.45)	109 (83.2)	-0.04 (0.22)	113 (80.1)	3.80 (1.98)	93 (83.0)	0.18 (2.13)	113 (80.1)	6.66 (2.31) [*]	92 (83.6)	-0.47 (2.37) [†]
Clinical	28 (19.0)	1.76 (0.51)	22 (16.8)	0.03 (0.24)	28 (19.9)	3.70 (1.57)	19 (17.0)	-0.20 (1.80)	28 (19.9)	8.03 (3.07) [*]	18 (16.4)	-1.47 (2.15) [†]

[†]p< .10; *p< .05; **p< .01; ***p< .001.

Note. Subclinical = CBCL scores < 60; Clinical = CBCL scores ≥ 60